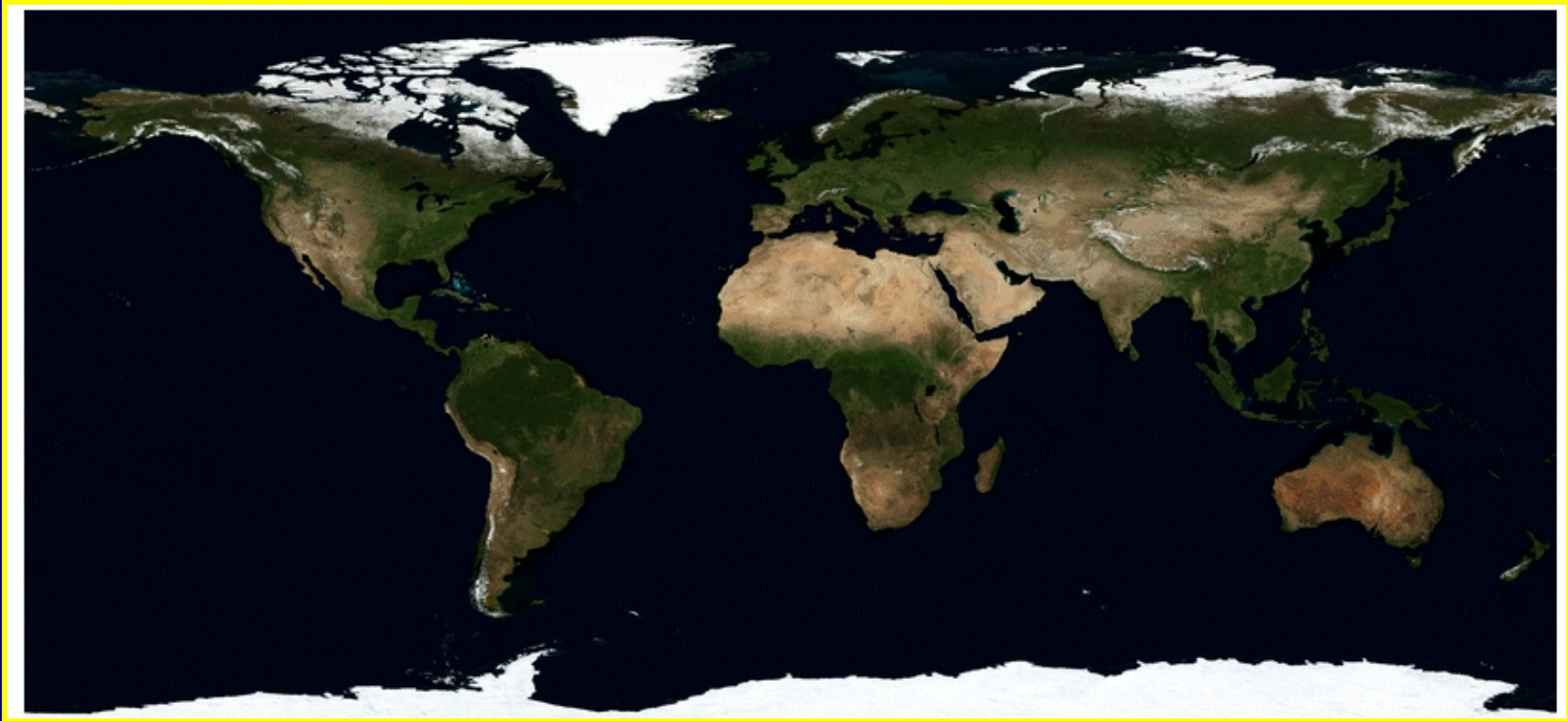


# Global Agriculture Land Cover: Data, Analysis, & Dissemination



Compton Tucker  
NASA/GSFC & CCSP

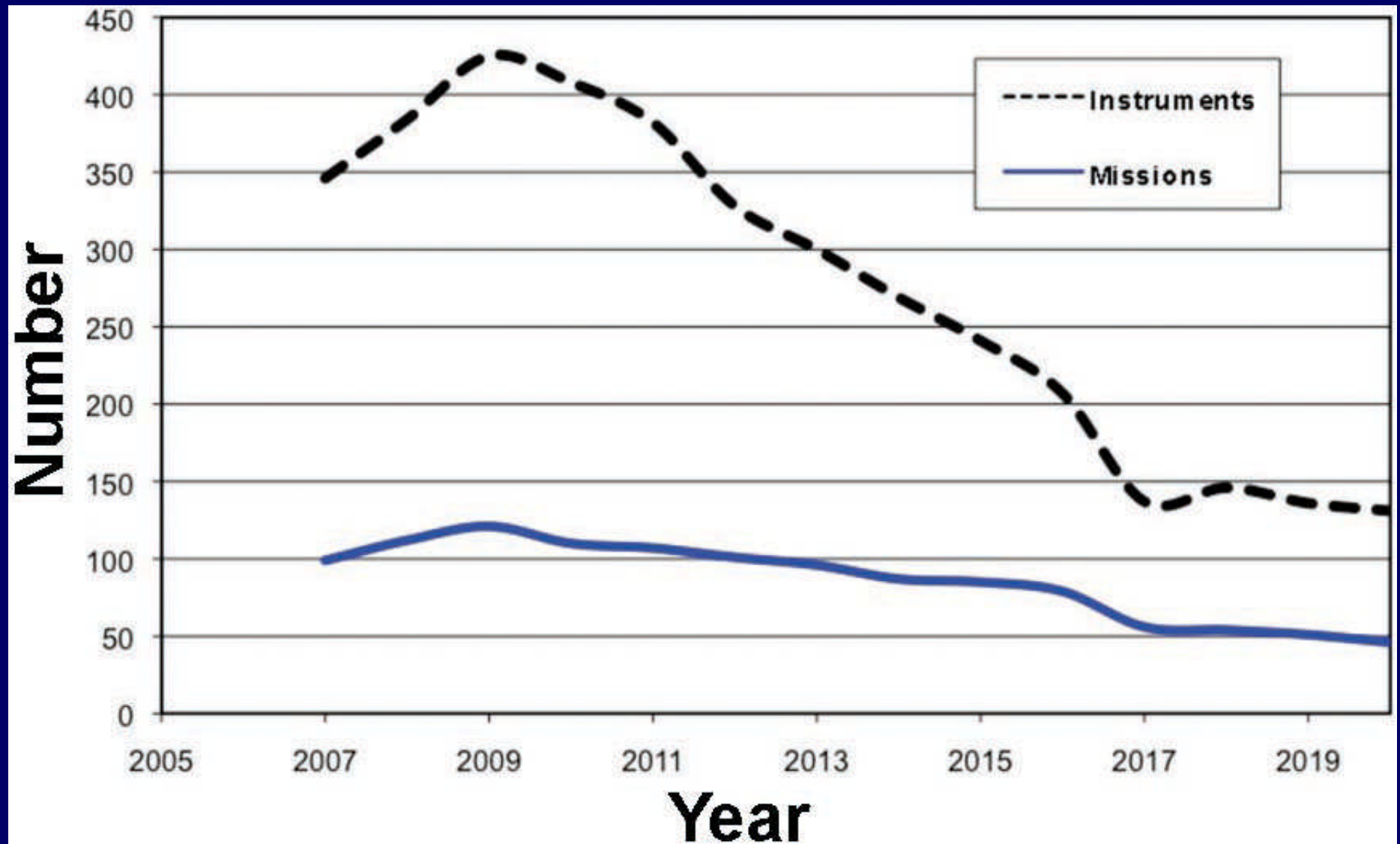


April 22, 2009

# **Global Agricultural Land Cover -- Satellites are crucial for global data**

- **Land Photosynthesis – time series**
  - **AVHRR-MODIS-VIIRS**
- **Land Use/Land Cover Change –**
  - **Landsat, AWiFS, & AVHRR-MODIS**
- **Vegetation height and structure**
  - **DESDynI's InSAR & Lidar**
- **Quickbird/Rapid Eye**
  - **Hyper spatial data**

# Status of Civilian Space Assets

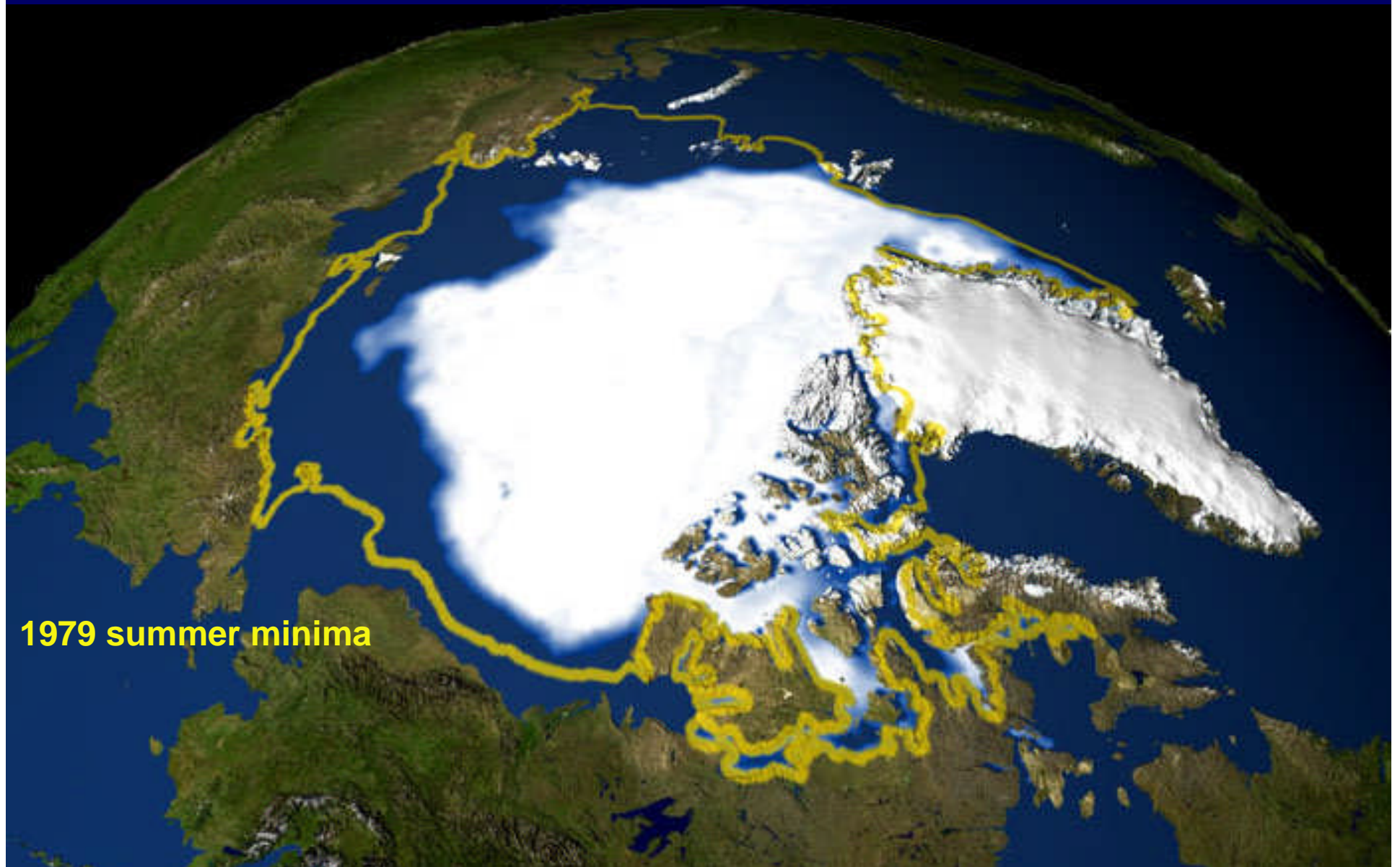


# Houston, We Have a Problem...

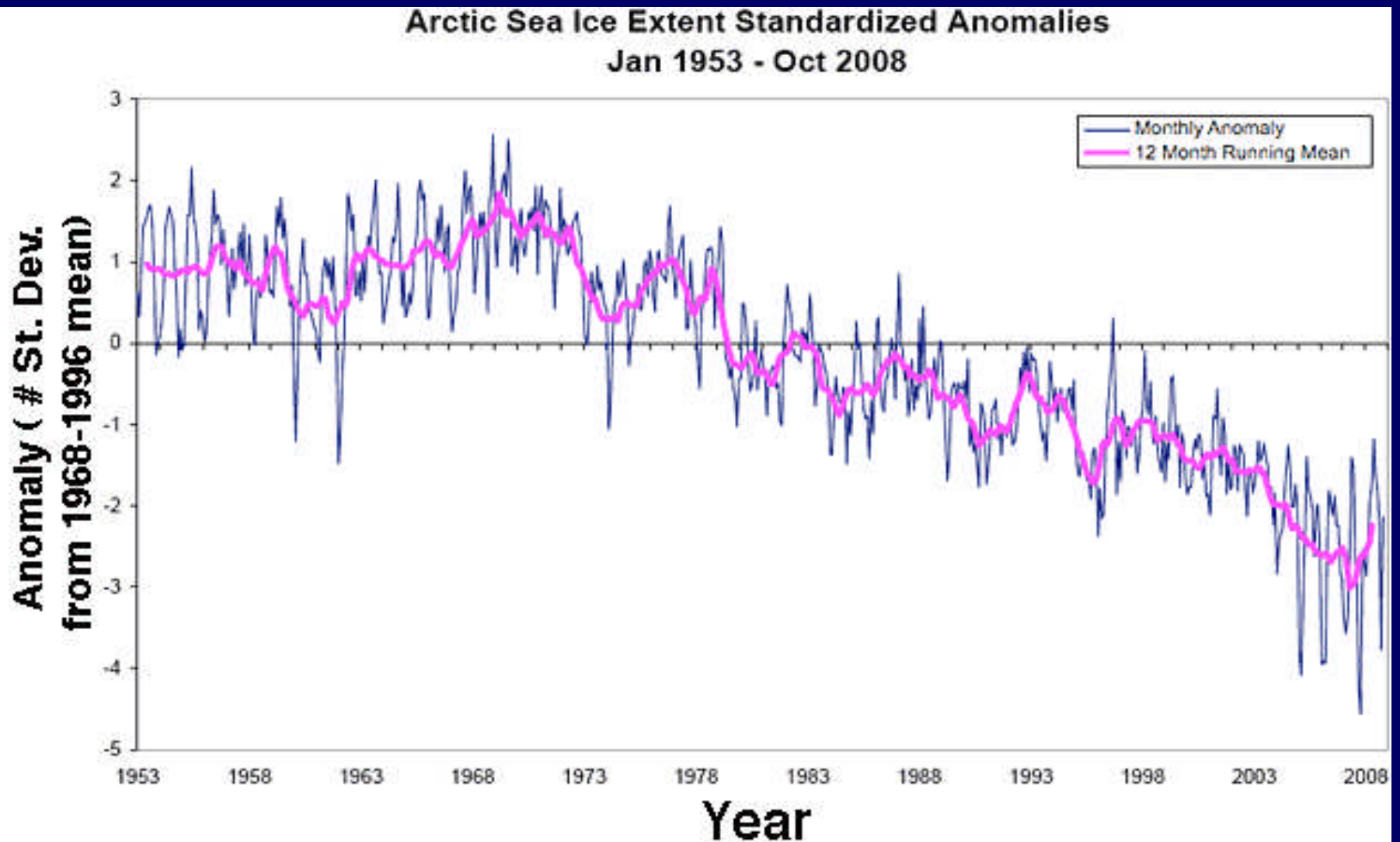
**We are altering  
our planet's  
climate**



# Arctic Sea Ice Trends

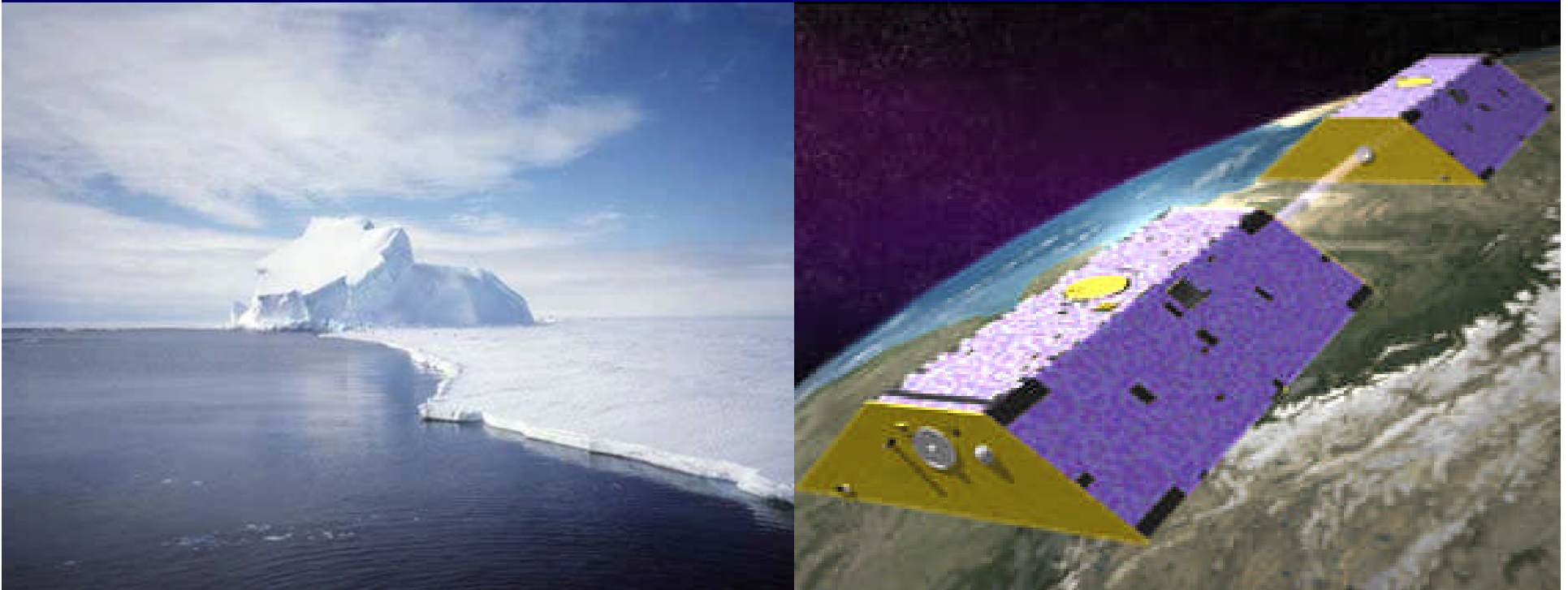


# Arctic Sea Ice Trends



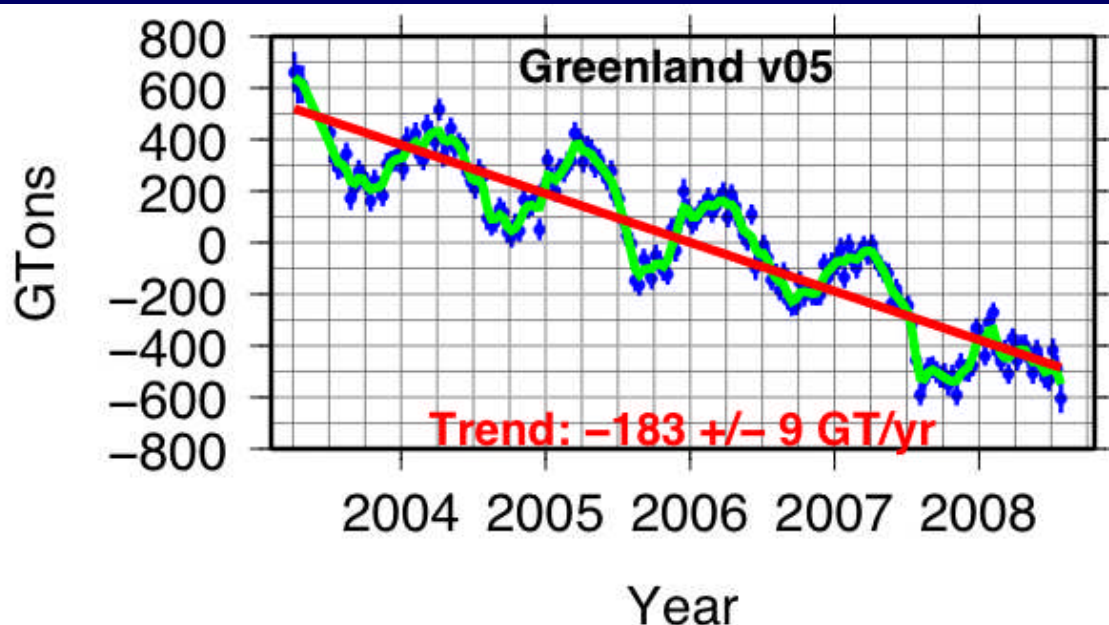
# Seasonal and Interannual Evolution of the Earth's Land Ice from GRACE MASCON Solutions

S. B. Luthcke, D.D. Rowlands, J.J. McCarthy, A.A. Arendt,  
H.J. Zwally, W. Abdalati, D.K. Hall, J.P. Boy, F.G. Lemoine



*AGU Fall Meeting Dec. 19, 2008, San Francisco, CAC43A-05*

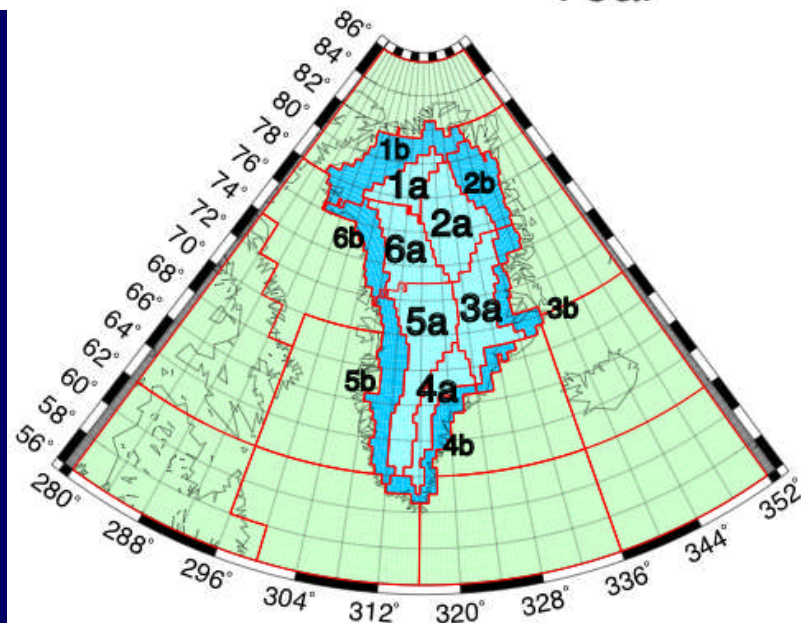
# Greenland Mass Balance from GRACE Mascon Solution



NASA GSFC mascon solution

Update to:

Luthcke, S.B., H.J. Zwally, W. Abdalati, D.D. Rowlands, R.D. Ray, R.S. Nerem, F.G. Lemoine, J.J. McCarthy and D.S. Chinn, "Recent Greenland Ice Mass Loss by Drainage System from Satellite Gravity Observations," *Science* 314, 1286 (2006) (10.1126/science.1130776).



Time Period	Trend Gt/yr
Jul03 - Jul05	$-105 \pm 11$
Jul03 - Jul06	$-136 \pm 8$
Jul03 - Jul07	$-150 \pm 6$
Jul03 - Jul08	$-183 \pm 9$



“Ladies and Gentlemen, it’s time we gave some serious thought to the effects of global warming”

# **Key climate & Ag. sensors**

**Absolutely crucial climate/Ag. sensors:**

- Landsat 1972 – now**
- AVHRR-MODIS-VIIRS 1981 -- now**
- Lidar & InSAR for the 3<sup>rd</sup> Dimension  
(DESDnyl)**

**Why?**

**Land use, land cover change/climate**

**Carbon cycle land/climate**

**Global Agriculture monitoring**

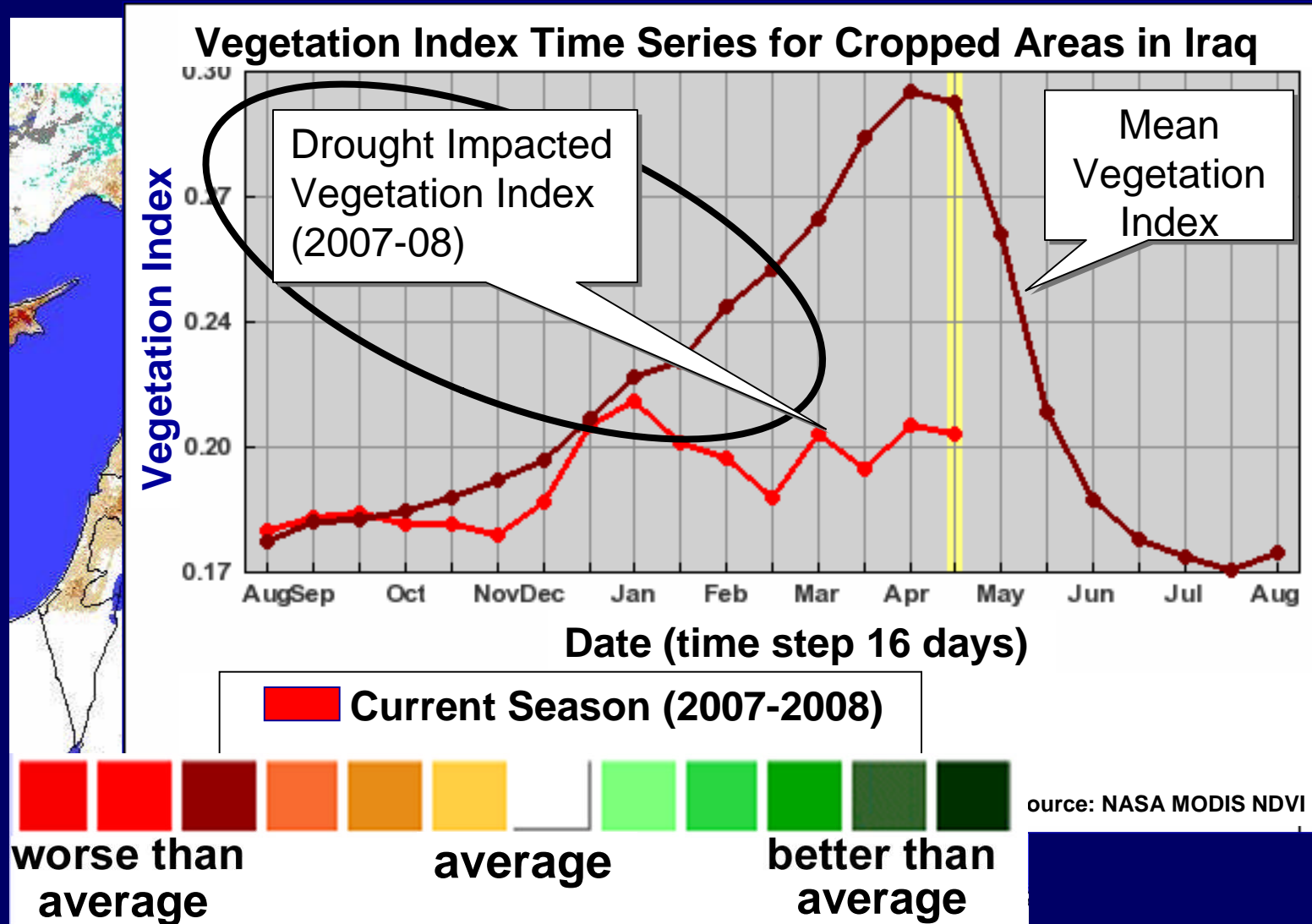
# **Landsat – A key climate & Agricultural land cover sensor?**

- 1. 30 m spatial resolution close-to-perfect match to surface variability (Townshend and Justice 1988)**
- 2. Spectral bands are well situated**
- 3. Repeat cycle OK**
- 4. Excellent data system**

# How to enhance Landsat

- Landsat exploits the spatial & spectral domains
  - 30 m spatial resolution excellent
  - Excellent spectral band selection
- Exploit the time domain (e.g. AVHRR, MODIS, Seawifs, etc.) but at 30 m spatial resolution with TM/ETM spectral bands
- Wider field of view, 4-5 day repeat cycle
- Build multiple instruments (e.g. Landsat-5's TM) = Continuity!!

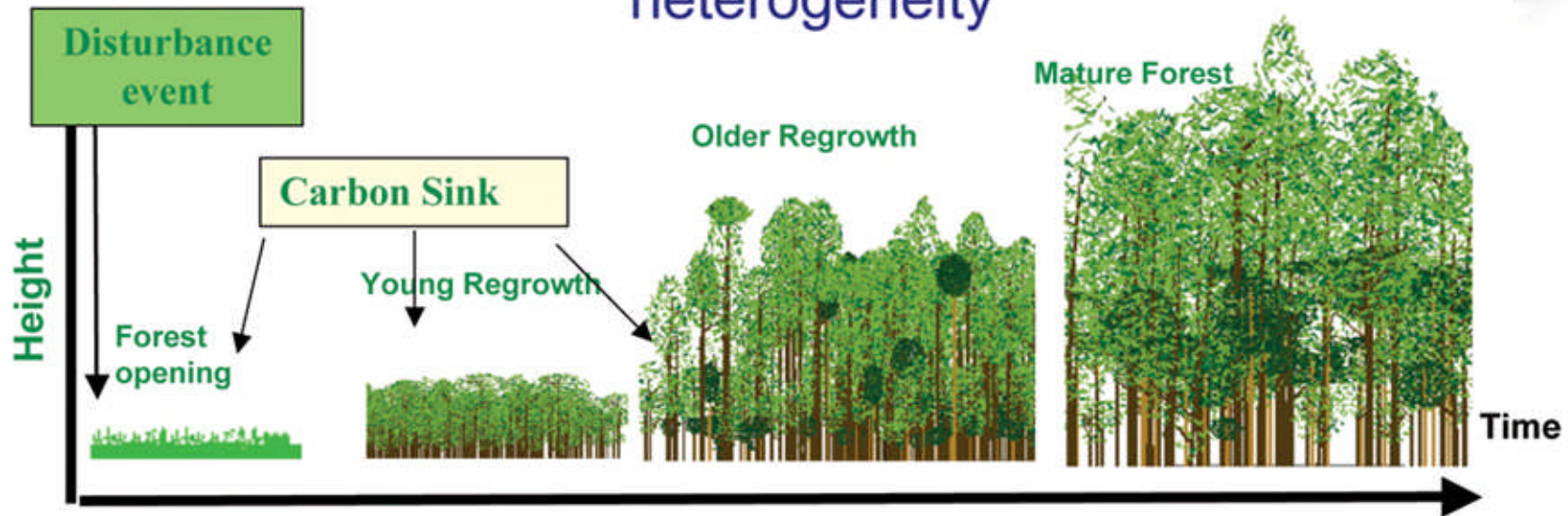
# Tracking the 2007-08 Iraq Drought through the GLAM MODIS Web-Interface NDVI Anomalies





# Ecosystem changes can be seen in vertical height & density distributions of vegetation & in spatial heterogeneity

Goddard  
Space  
Flight  
Center

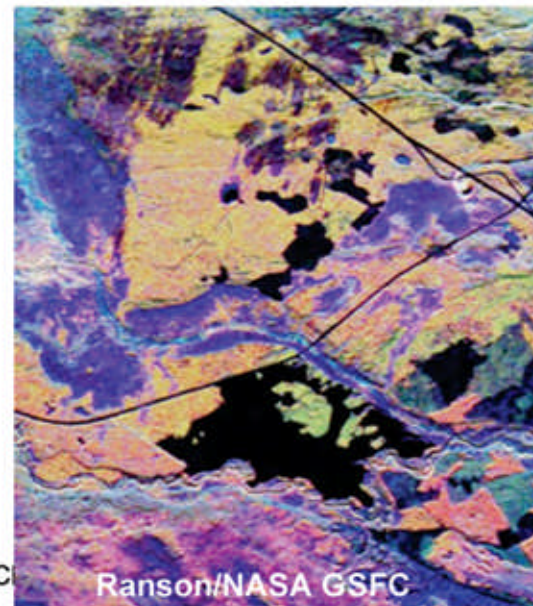


(figure from J. Drake)

More Biomass →



Disturbances  
from fire,  
logging,  
insects,  
disease, storms



Forests tend to be patchy due to natural and human disturbances.

Radar image from Canada shows evidence of fires (dark areas at top) and logging (e.g., black features in center)

Disturbances are major forces that determine transition of forest stands, landscapes, and regions to & from carbon sinks to sources .

# MODIS Rapid Response Interface with FAS Crop Explorer

USDA United States Department of Agriculture  
Foreign Agricultural Service

Linking U.S. Agriculture to the World

## Crop Explorer

Toolbox

**r13c23**  
08/04/08 (Day 217 of 2008)

[Previous Day](#) | [Next Day](#)

[Last 30 Days All Images](#)

**7-2-1 Composite (SWIR/NIR/RED)**

**Terra (AM)**  
Pixel size: 250m | 1km | 2km

**Aqua (PM)**  
Pixel size: 250m | 1km | 2km

**True Color**

**Terra (AM)**  
Pixel size: 250m | 1km | 2km

**Aqua (PM)**  
Pixel size: 250m | 1km | 2km

**NDVI Images**

**Terra NDVI**  
Pixel size: 250m | 1km | 2km

**Aqua NDVI**  
Pixel size: 250m | 1km | 2km

**MODIS Image Gallery r13c23**

(MODIS Image Archive is available from 05/20/2008)

Select a date to view the past MODIS data

8 4 2008 Go

Select a new region to view the MODIS data

**Download Images**

MODIS Image Gallery [FAQ's](#)

What do the different band combinations mean?  
What do the red boxes on the image mean?  
**MODIS Rapid Response System**

USDA United States Department of Agriculture  
Foreign Agricultural Service

Linking U.S. Agriculture to the World

## Crop Explorer

Toolbox

[Click here to add your Comments/Feedback](#)

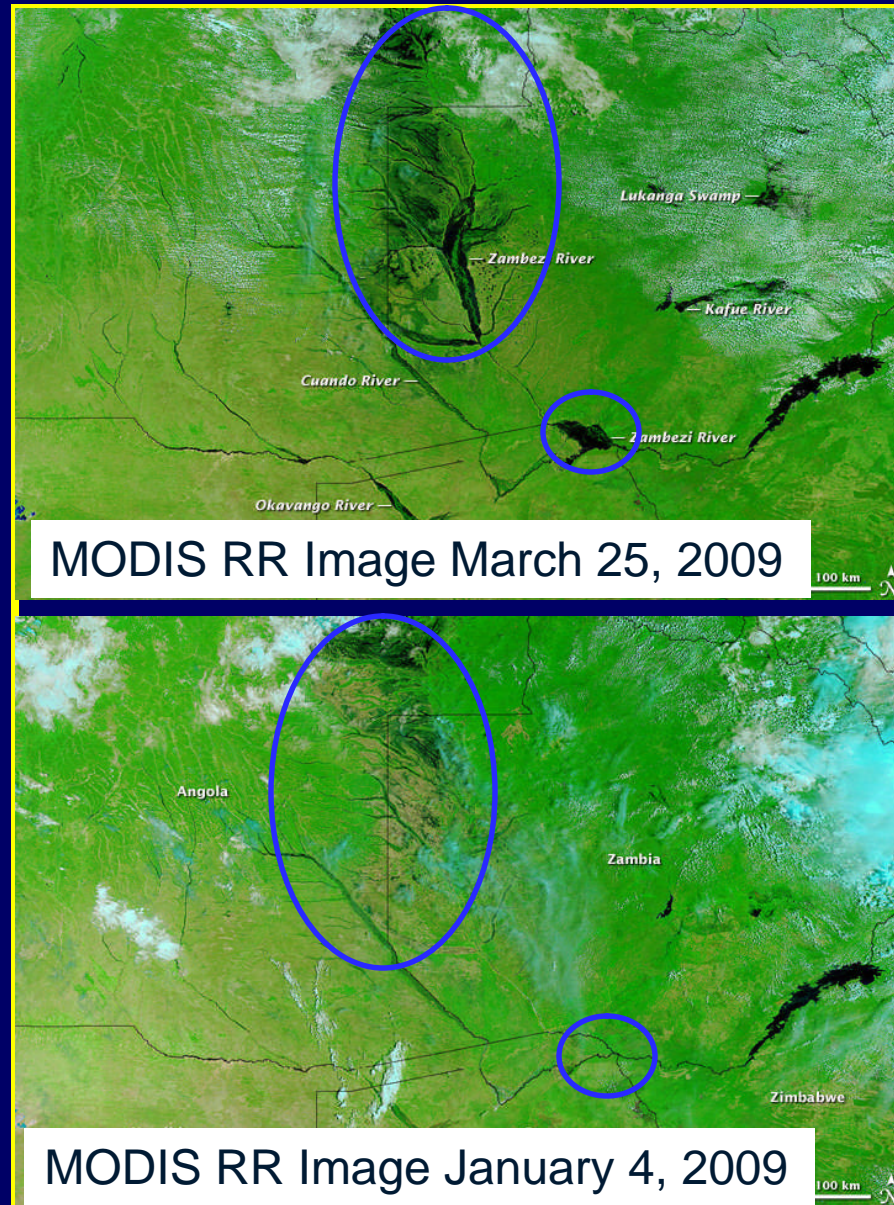
**Project Information**  
NASA Satellites Improve Response To Global Agricultural Change

USDA  
Foreign Agricultural Service

NASA

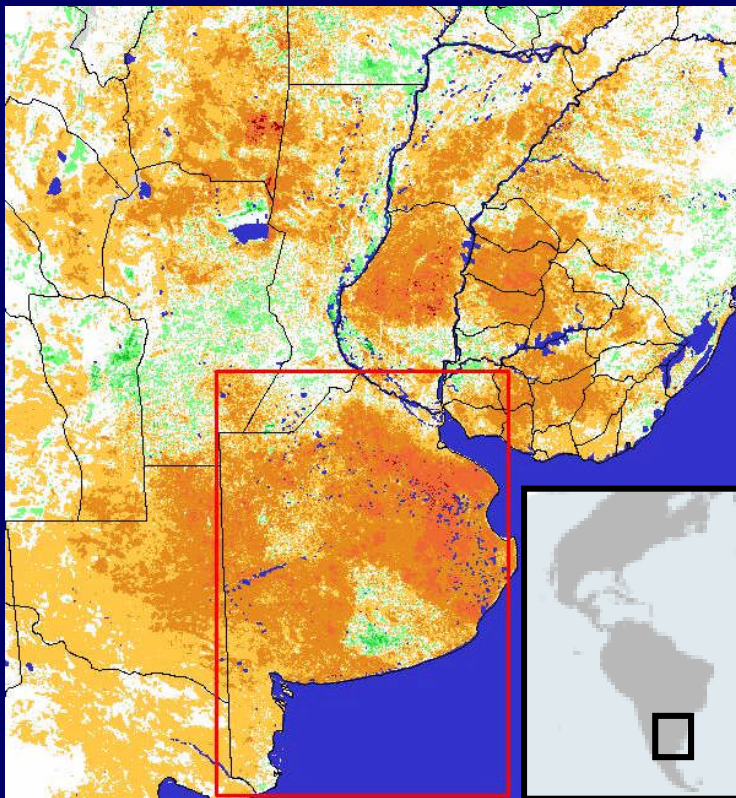
ASTC

# Monitoring Floods in the Zambezi River with MODIS Rapid Response

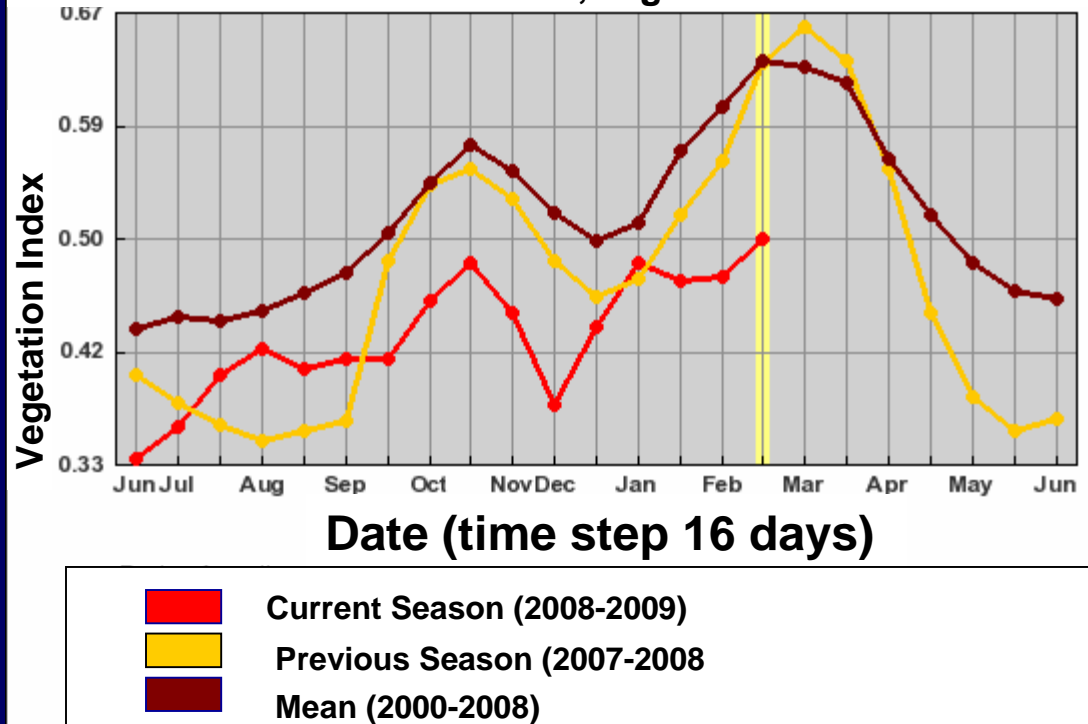


# Example of Utility of the GLAM MODIS NDVI DBMS to Track Current Drought Impact on Crops in Argentina

Buenos Aires NDVI Anomaly Image  
Feb 02-Feb 17, 2009



Vegetation Index Time Series for Cropped Areas in  
Buenos Aires, Argentina




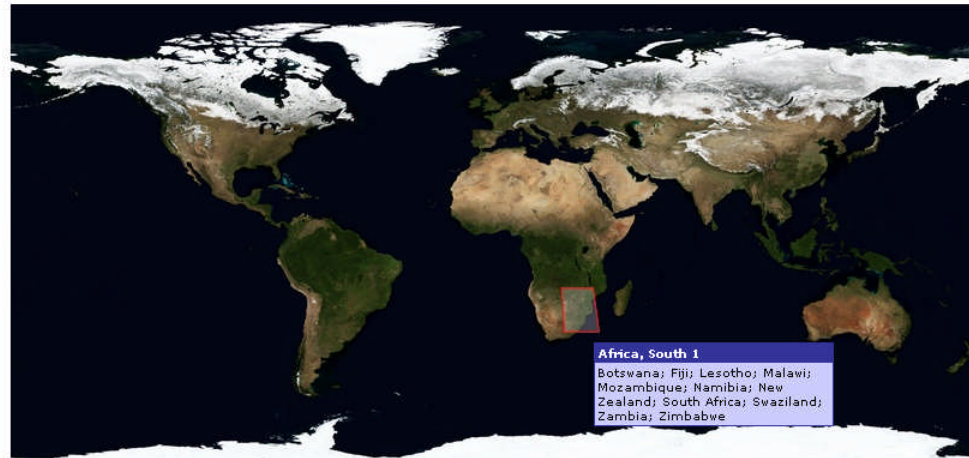
# GLAM Web Based MODIS DBMS Component

## 250-m VI/MODIS time-series from 2000-present

- A global NDVI time-series database is produced at a spatial resolution of 250 meters with a 16-day compositing period
- - Current system data delivery lag is between 3-14 days after last day of composite

### 250-meter MODIS/NDVI Time Series Database from the Global Agriculture Monitoring (GLAM) Project

Please select your region of interest by clicking on the globe  or selecting from the list



Select Region  

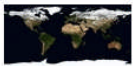


# First Dataset from New FAS GLAM NRT System!

Latest MODIS NDVI standard product available is the Feb 18- March 5<sup>th</sup> composite

250-meter MODIS/NDVI Time Series Database // Africa, South 1 // 2009-Feb-18 to Mar-05

[Bookmarkable Link](#) ?



Select Region: Africa, South 1 ?

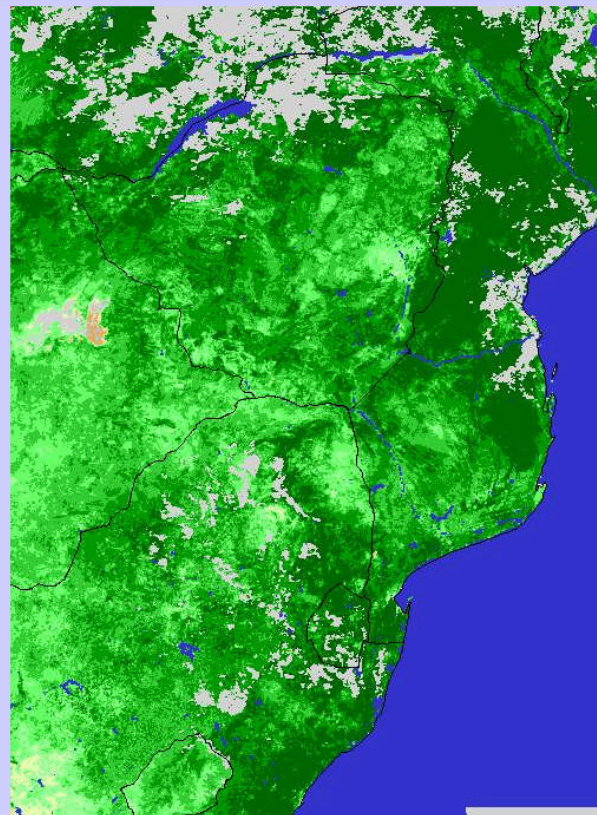
Data Source: Terra (AM) Only ?

[Go To Data Access App](#) ?

[Go To Data Delivery Directory](#) ?

## Regional Image [View] ?

Click to Show Detail. Red box indicates bounds of detail image. Each pixel is 2.5km..

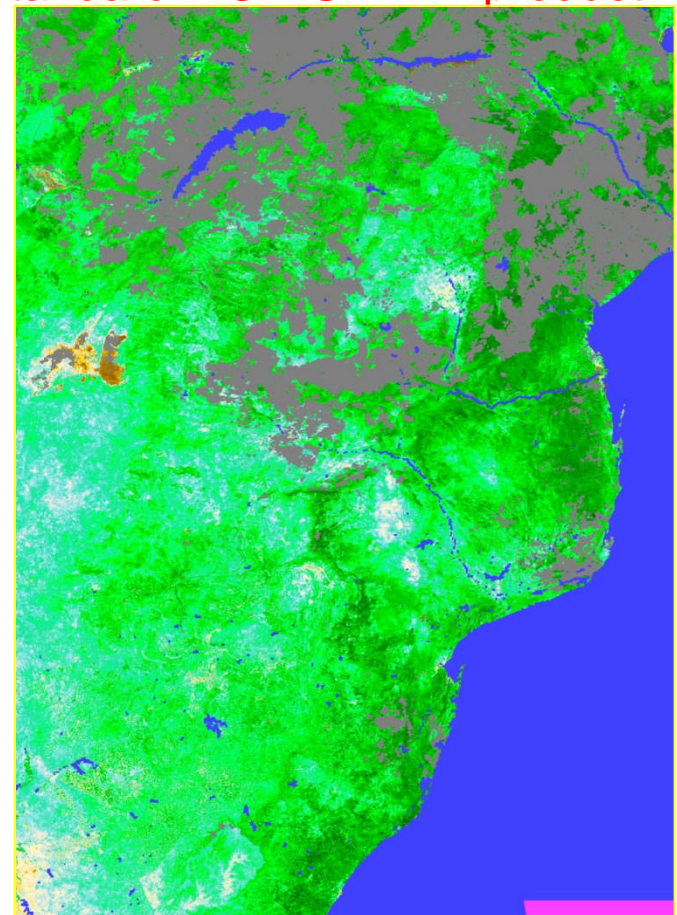


## Regional Image Date Select ?

Click to Select Regional Image Date

2009-Feb-18 to Mar-05 ^  
2009-Feb-02 to Feb-17  
2009-Jan-17 to Feb-01  
2009-Jan-01 to Jan-16  
2008-Dec-18 to Jan-02  
2008-Dec-02 to Dec-17  
2008-Nov-16 to Dec-01  
2008-Oct-31 to Nov-15  
2008-Oct-15 to Oct-30  
2008-Sep-29 to Oct-14  
2008-Sep-13 to Sep-28  
2008-Aug-28 to Sep-12  
2008-Aug-12 to Aug-27  
2008-Jul-27 to Aug-11  
2008-Jul-11 to Jul-26  
2008-Jun-25 to Jul-10  
2008-Jun-09 to Jun-24  
2008-May-24 to Jun-08  
2008-May-08 to May-23  
2008-Apr-22 to May-07  
2008-Apr-06 to Apr-21  
2008-Mar-21 to Apr-05  
2008-Mar-05 to Mar-20  
2008-Feb-18 to Mar-04 v

NDVI Image for March 6-21 2008  
Available since Monday 23<sup>rd</sup>  
Several days prior to the  
standard MODIS NDVI product!

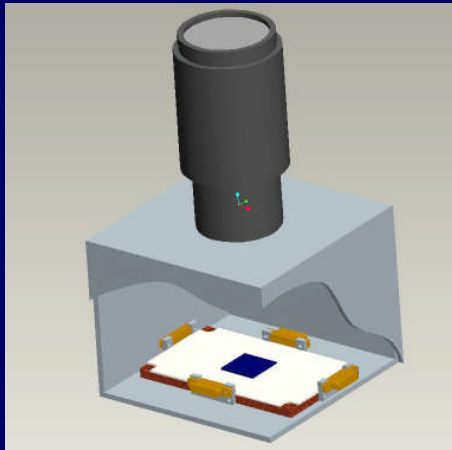


# Collaborators

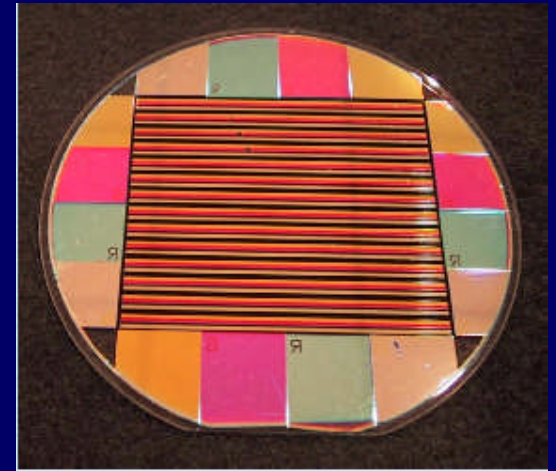
---

- **NASA/GSFC**
  - Compton Tucker, Assaf Anyamba, Ed Masouka, Jen Small, Ed Pak, Jeff Schmaltz
- **University of Maryland Department of Geography**
  - Chris Justice, Mark Sullivan, Eric Vermote
- **South Dakota State University**
  - Matthew Hansen, Kyle Pittman
- **USDA Foreign Agriculture Service (FAS)**
  - Brad Doorn, Curt Reynolds

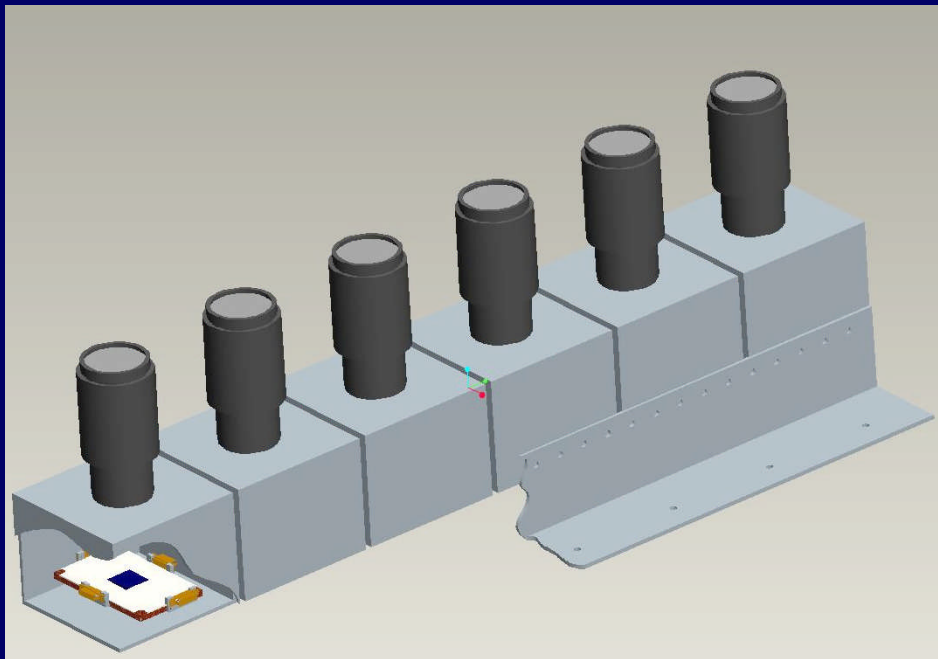
# TD30m Venture Class Instrument



**Single Camera Module**  
One 640 x 512 InGaAs Det. Array  
5 beam slices per module  
Swath = 96 km  
GSF= 30 m  
Spectral band = 0.4 - 1.7  $\mu\text{m}$   
Several modules for operation  
~3% module overlap



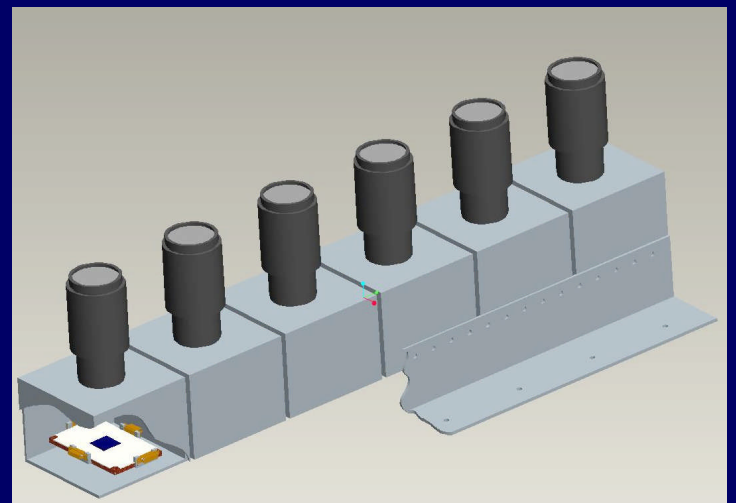
**Multi-band Filters from Barr unpackaged**



**Data Rate per Camera Module:**  
Assuming 700 nm sun sync. Orbit,  
Velocity of S/C = 7000 m/sec.  
Using 30 m ground resolution would  
Require 6.7  $\mu\text{second}$  pixel readout  
Well within the 190 frames/sec.  
detector speed

# TD30m Venture Class Costing

- Each camera module would be ~ \$3M, Total for 6 modules = <\$20M
- The Camera Electronics Box (CEB) ~ \$10M
- Alignment, Integration & Test ~ \$3M
- Calibration ~ \$2M
- Data Compression ~\$6M
- Total Instrument: ~\$40M
- Major in-house project



# GLAM System Web Interface for Querying and Analyzing MODIS VI Time Series

250-meter MODIS/NDVI Time Series Database // Australia, West // 2008-Jul-11 to Jul-26 [Bookmarkable Link](#)

Select Region:  [Go To Data Access App](#) [Go To Data Delivery Directory](#)

Data Source:  [Go To Data Access App](#) [Go To Data Delivery Directory](#)

Preferred Data:  [Go To Data Access App](#) [Go To Data Delivery Directory](#)

Short-term Mean:  [Go To Data Access App](#) [Go To Data Delivery Directory](#)

**Regional Image** [Click to Show Detail. Red box indicates bounds of detail image. Each pixel is 2.5km.](#)

**Regional Image Date Select** [Click to Select Regional Image Date](#)

2008-Jul-11 to Jul-26  
 2008-Jun-25 to Jul-10  
 2008-Jun-09 to Jun-24  
 2008-May-24 to Jun-08  
 2008-May-08 to May-23  
 2008-Apr-22 to May-07  
 2008-Apr-06 to Apr-21  
 2008-Mar-21 to Apr-05  
 2008-Mar-05 to Mar-20  
 2008-Feb-18 to Mar-04  
 2008-Feb-02 to Feb-17  
 2008-Jan-17 to Feb-01  
 2008-Jan-01 to Jan-16  
 2007-Dec-19 to Jan-03  
 2007-Dec-03 to Dec-18  
 2007-Nov-17 to Dec-02  
 2007-Nov-01 to Nov-16  
 2007-Oct-16 to Oct-31  
 2007-Sep-30 to Oct-15  
 2007-Sep-14 to Sep-29  
 2007-Aug-29 to Sep-13  
 2007-Aug-13 to Aug-28  
 2007-Jul-28 to Aug-12  
 2007-Jul-12 to Jul-27

Image:   [View \(821\)](#)

Graph:   [View \(821\)](#)

Water:

Australia, West  
 2008-Jul-11 to Jul-26  
 UL: -22.41444° 113.10040°  
 LR: -35.22978° 130.20001°

Image Type:  [Polygon Options](#)

Water Mask:  [Draw?](#) [Label?](#) [Zoom To](#)

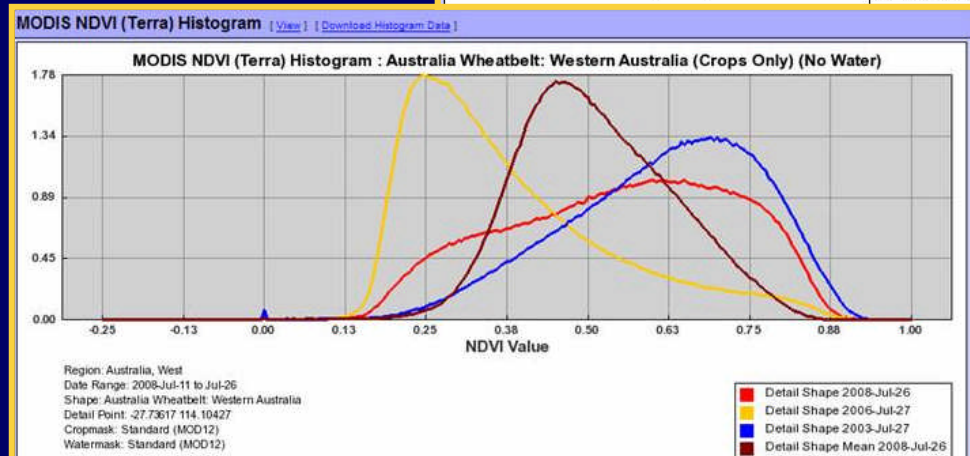
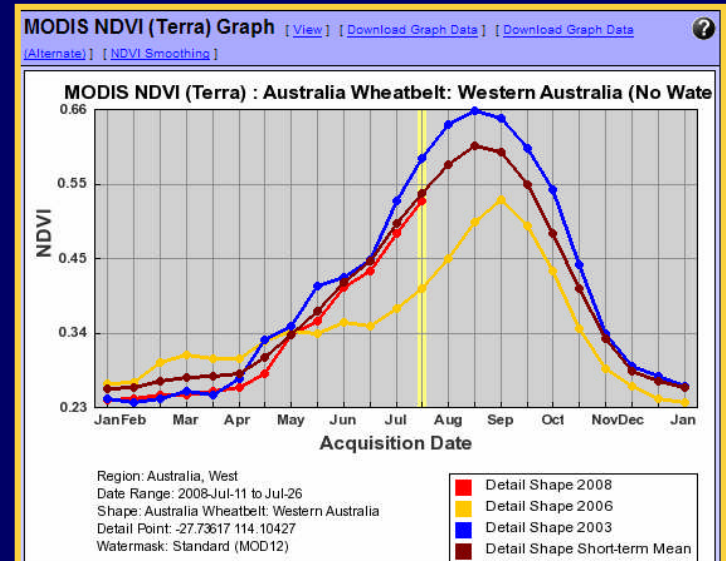
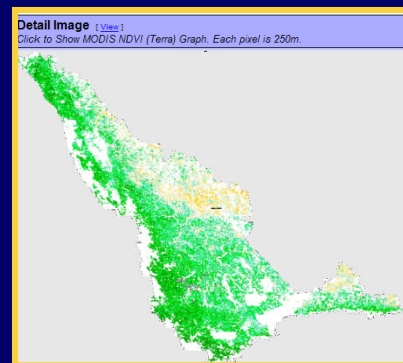
Crop Mask:  [Country](#) [Admin](#) [IU](#)

Greenness Threshold:  [Yes](#) [No](#)

Palette:  [Yes](#) [No](#)

Click Type:  [Yes](#) [No](#) [Australia Wheatbelt: Western Australia](#)

Update Im:  [Shape: Country](#) [Shape: Admin](#) [Shape: IU](#) [Shape: Australia Wheatbelt](#)



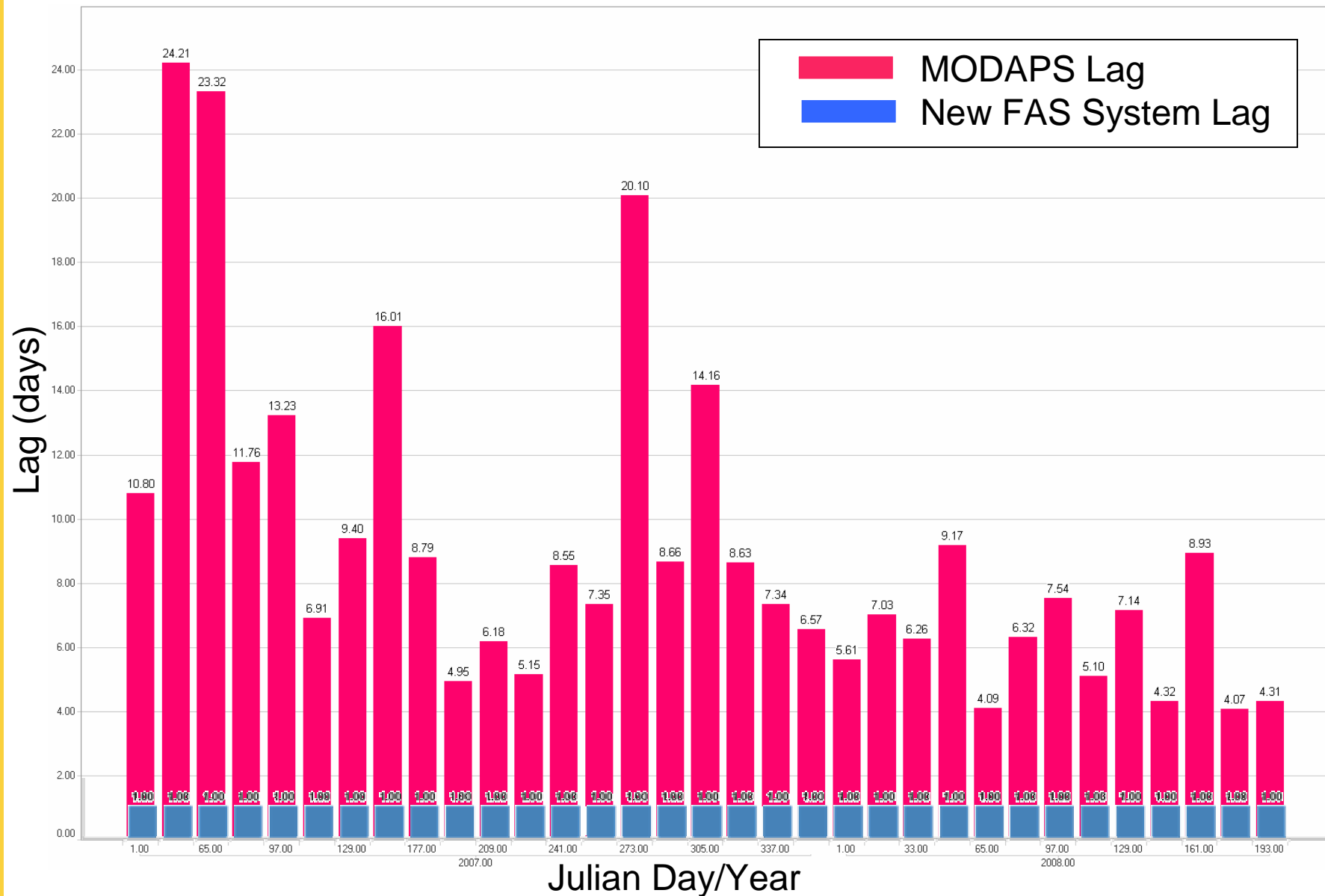
[About The Data](#)

[Feedback](#)

Version 0.3.0-beta-15 (4/1/2008) -- [Version History](#)



# GLAM System Data Delivery Lags 2007-2008 Versus New FAS System Lags (in number of days after last compositing day)



# Gravity Recovery & Climate Experiment



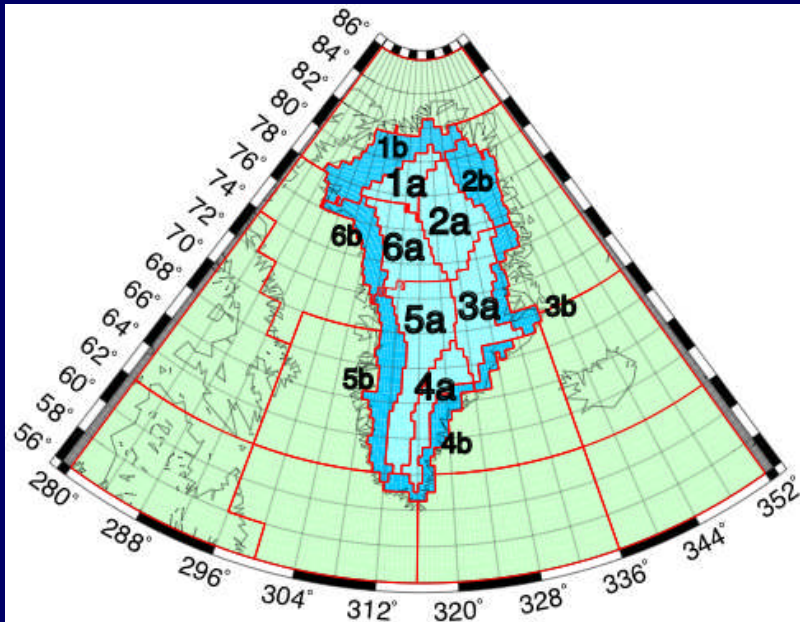
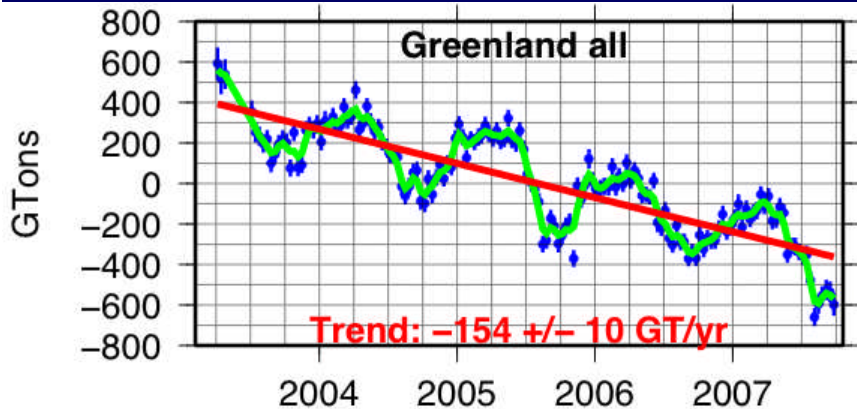
500 km orbit

220 km separation

Distance accuracy  $\pm 0.001$  mm

## Greenland Ice Mass Flux from GRACE mascon solution

NASA GSFC mascon solution (update to Luthcke et al. Science 2006)



Losing 154 Gt of ice per year !  
(update to Luthcke et al. Science 2006)

154 Giga-ton = 154,000,000,000 metric tons

1 metric ton = 2,205 lbs.

154 Giga-ton ~ 168 km<sup>3</sup> of ice or 40.3 mi<sup>3</sup> of ice

Nearly 2.5 times the amount of water in the Chesapeake bay !

Nearly 10 times the average annual flow of the Colorado river !

0.43 mm/yr to global sea level rise.

Photo Credit: Roger Braithwaite